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Commentary

Cliffs, trees, and ground-nesting raptors

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In their recent paper, Martínez-Abraín and Jiménez (2019) presented an appealing hypothesis about the potential evolutionary consequences of being able to build nests on trees for diurnal raptor species. According to the authors, the fact that only some species of cliff-nesting raptors provide sticks, making a "real nest" on the cliff is due to evolutionary load of formerly tree nesters. They provide an analysis showing that probably those species that do not provide nest material when nesting in cliff are the only truly rupicolous species.

This suggestion is a very interesting and original one, and allows the authors to make phylogenetically testable predictions. Additionally, some discussion about the previous origin of these species would be inferred from current nesting habits. For example, large eagles like Golden eagle (*Aquila chrysaetos)*, Spanish imperial eagle (*A. adalberti)*, European Imperial Eagles (*A. heliaca)*, Bonelli's Eagle *(A. fasciata*) and others that supply nest on cliffs—or even they don't breed on cliffs at all—may have evolved in forests. I would like to add some additional considerations to this hypothesis.

Nesting on trees or cliffs is not the only possibility for diurnal raptors. Even though it is true that most of them breed on trees or cliffs, several species of diurnal raptors also nest on the ground. Some are frequently or totally ground-nesters, like the Tawny eagle (*Aquila rapax*), Pale harrier (*Circus macrourus*), Montagu's harrier (*C. pygargus*), or Hen harrier (*C. cyaneus*) (Volchanetskii and Yal'tsev 1934, Volchanetskii 1937). In other species, ground-nesting occurs less frequently, as in the cases of the Pallas' fish eagle (*Haliaeetus leucoryphus*), the Bald eagle (*H. leucocephalus*), the Ferruginous Hawk (*Buteo regalis*), the Black-chested Buzzard-Eagle (*Geranoaetus melanoleucus*), the Osprey (*Pandion haliaetus*), the Golden eagle, the Egyptian Vultures (*Neophron percnopterus*) and the Peregrine (*Falco peregrinus*), among others (Lokemoen and Duebbert 1976, Newton 1979, Novaro et al. 2000 , Monson 2001, Katzner et al. 2003, Gangoso and Palacios 2005, Martin 2005, Oparin 2008, Ellis et al. 2009, Pagel et al. 2010, Ratcliffe 2010). Ground nests are generally found in remote areas without large presence of both humans and terrestrial predators. Typically they are more frequent—but not exclusively—on islands (Del Hoyo et al. 1994, Ellis et al. 2009, Ferguson-Lees and Christie 2001). Nevertheless, ground nesting among raptors continues to be a confounding nesting behavior, especially in areas where there are potential terrestrial predators and elevated substrates available.

Whatever the reason for this behavior, there is a clear difference among true cliff nesters and true tree nesters (*sensu* Martínez-Abraín and Jiménez 2019) because the supply or lack thereof for sticks follows the same pattern observed by these authors when breeding occurs on cliffs, i.e. true tree-breeders nesting on the ground still use sticks and build a real nest on the ground, which is not the case with true cliff-breeders. This point, in my opinion, reinforces the hypothesis of Martínez-Abraín and Jiménez, showing that some evolutionary load is working on true tree-nesters and that they have to supply sticks even on cliffs and/or the ground when they breed.

Several suggestions can be made about how this flexible behavior of selecting where to breed has evolved, and why some raptor species seem much more flexible than others. But from a conservation point of view, being able to breed on trees or alternatively cliffs must have been a critical factor in responding to human interference during the 20th century.

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